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Challenges implementing social constructivist learning approaches: The case of Pictation

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Most medical professionals need to make meaning of clinical images collaboratively with colleagues. To develop this ability in our Health Sciences students, we designed a social constructivist learning activity where students jointly annotate clinical images via an in-house web application, Pictation. We conducted a case study with 85 third-year students using Pictation alongside lectures and tutorials. The learning activity was evaluated via a survey questionnaire, interviews, and observations. Three challenges in implementing a social constructivist learning activity were identified: students' inadequate prior knowledge; embarrassment in exposing inadequate understanding to peers; and need for certainty. These challenges pose particular dilemmas for teachers wanting to implement social constructivist learning because such learning approaches inherently imply that students: have incomplete prior knowledge; are willing to expose incomplete understanding to peers; and are comfortable with uncertainty. Our findings and recommendations can serve to guide teachers and academic developers in implementing social constructivist learning in realistic contexts.

Keywords: social constructivism; technology integration; medical education

Introduction

Medical practitioners (particularly pathologists, radiologists, ophthalmologists, dermatologists, and surgeons) are routinely asked to recognise and interpret abnormal physiological structure and function in images, such as patient photographs, x-rays, or micrographs. In practice, images are often interpreted collaboratively and by consensus opinion. Medical education should hence prepare students for collaborative demands by developing their ability to make meaning of clinical images with peers.

Social constructivist learning approaches can help students develop collaborative meaning-making by foregrounding social interaction. Vygotskian social constructivist theory holds that learning results from "internalisation" of social practices (Vygotsky, 1978, p. 56). Through social interaction (e.g., problem-solving as a group), learners transform knowledge from the social to individual planes, negotiating various meanings of a particular phenomenon to arrive at a shared understanding.

Strictly speaking, social constructivism provides a descriptive account of a particular learning process. However, drawing on descriptive learning theories, educational technologists can make inferences and prescriptions about how learning experiences should be designed (Reigeluth, 1989). In this sense, we "implement" social constructivist learning approaches in this case study.

Social constructivist principles have been shown to be effective for the teaching of pathology: for example, Canfield (2002) and Weurlander, Masiello, Söderberg, and Wernerson (2009) report on successful interventions where students collaboratively discussed and diagnosed cases.

We designed a similar social constructivist learning activity in a university pathology course, where students collectively annotated images and diagnosed cases via a web application called Pictation. Pictation was specifically designed for the sharing and annotating of digital images. Importantly, Pictation was designed to respect social constructivist principles: tutors can group students to work on particular images, making it possible to structure collaboration; students can reply to each other's annotations, enabling dialogue. A video clip on Pictation's full features (e.g., zooming and panning images; drawing shapes) is available at https://unitube.otago.ac.nz/view?m=Lib77198fqk.

Tutorial redesign

Pictation was implemented within a third-year university course, Principles of Pathology. This course's main objective was to develop students' understanding of normal and abnormal structure and function of the human body over a 12-week semester. Each week, students attended three lectures and participated in one tutorial on a particular topic (e.g., acute inflammation, chronic inflammation).

Pictation was used to enhance tutorials, rather than lectures, as tutorials gave students opportunities for discussion in small groups (approximately 15-20 students per tutorial). Students were expected to read lecture material and consider given case questions before tutorials. Drawing on textual information and photographs, case questions typically asked students to: describe pathological features depicted in the images; and suggest diagnoses. A typical tutorial question is shown below:

> PAS staining of kidney samples stain the basement membrane purple-pink. A normal kidney is shown in Image A, while a diabetic kidney is shown in Image B. Describe what you see in your case image (Image C) by annotating the image. What is your diagnosis?

Previously, tutorials typically ran as follows: working through case questions, tutors would ask individual students for answers and provide evaluative feedback on their responses. If a student could not answer a question, tutors would ask someone else, or provide the answer themselves. This Initiation-Response-Evaluation (IRE) communication pattern (e.g., "Can you see the neutrophils?"- "Is this one of them?"- "Yes") is typical in many classrooms (Cazden & Beck, 2003). In redesigning these tutorials, we aimed to shift class interaction from more didactic IRE to more dialogic discussions.

Case images previously were either black-and-white photographs in the students' individual tutorial workbooks, or laminated colour photographs handed out during tutorials. These images were problematic for three reasons: first, colour is often needed to discern pathological features; second, students could not keep the laminated colour images for future revision (some were observed using their mobile phones to photograph these colour images); and third, most importantly, it was difficult for students to discuss around these photographs, particularly when pinpointing and sharing areas of interest with their peers and tutor.

In 2015, we redesigned these tutorials with Pictation as follows: a few days before the tutorial, one to three pathology cases were posted on Pictation for students to solve. Pictures were assigned to groups (approximately 5-6 students per group), and students could log on as individual members of the group, in their own time, and: (1) annotate images with pathological observations; (2) comment on each other's annotations; and (3) ask questions where they were unsure of particular pathological features/diagnoses. Students were expected to solve cases as a group, using lecture material and each other's annotations as scaffolds. Students were encouraged to 'have a go' answering case questions even if unsure of their answers. Tutors could review student annotations before tutorials, glean common trends and misconceptions, and address these during tutorials.

We expected student misconceptions because we designed Pictation cases to be beyond individual problem-solving and achievable only via collective problem-solving. In other words, we designed cases to be within our students' Zone of Proximal Development (ZPD), defined as:

> the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky, 1978, p. 86)

We positioned Pictation as a space where students could articulate their developing and incomplete understandings, focussing on the process of collaborative meaning-making, rather than the 'correct' answer. Case questions were deliberately designed to be open-ended in order to exploit the plurality of meanings students make (Jonassen, 1991).

Social constructivist learning approaches have been widely reported as being relevant and valuable in higher education (Harland, 2012). However, few studies specifically document real-world challenges faced when implementing social constructivist learning activities. This is surprising given that constructivism, as a theoretical explanation of how learning happens, offers little to teachers in the way of practical advice or teaching strategies (Davis & Sumara, 2002; Karagiorgi & Symeou, 2005).

A few studies reporting problems implementing such learning approaches come from the field of International Education, where the implementation of learner-centred education (including social constructivist learning) in different countries is "riddled with stories of failure" (Schweisfurth, 2011, p. 425). For example, Zhu, Valcke, and Schellens (2010) reported that Chinese teachers (accustomed to more hierarchical cultures) expressed low support for social constructivist learning approaches, compared with Flemish teachers.

Other such studies come from the field of Educational Technology: Lee, Huh, and Reigeluth (2015) reported instances of intragroup conflicts when implementing collaborative learning approaches; Loke et al. (2012) described challenges in 'reining in' free exploration into fixed class times; and Valtonen, Havu-Nuutinen, Dillon, Kontkanen, Vesisenaho, and Pöntinen (2013) highlighted issues with getting students to value collaborative learning processes.

In this paper, we build on this literature, identifying potential challenges in implementing social constructivist learning, and proposing solutions that may guide teachers and academic developers to implement social constructivist learning approaches in realistic contexts.

Method

We conducted a case study with 85 third year dental students enrolled in the course Principles of Pathology at the University of Otago. The students were divided into five tutorial groups led by five different tutors. The authors played two roles in this research project: authors one and two were researchers observing the tutorials; author three was the course coordinator and also facilitated one of the tutorial groups.

We redesigned tutorials by integrating Pictation over a 12-week semester (February-May 2015). We evaluated the Pictation activity in three ways: (1) student use of Pictation; (2) a survey questionnaire; and (3) two focus group interviews. Ethical approval was obtained from the university's human ethics committee.

To evaluate student use of Pictation, we collected data from the system database and logs, and observed student interaction in face-to-face tutorials. We observed low participation by students, both in terms of total number of annotations on images, and the rarity of student-student interaction in the online comments: students typically labelled discreet areas of images independently, and we observed few or no replies/questions between students (see Figure 1). Also, the quality of individual comments was relatively shallow: responses were usually single-word diagnoses with no explanatory details showing how students arrived at their conclusions.

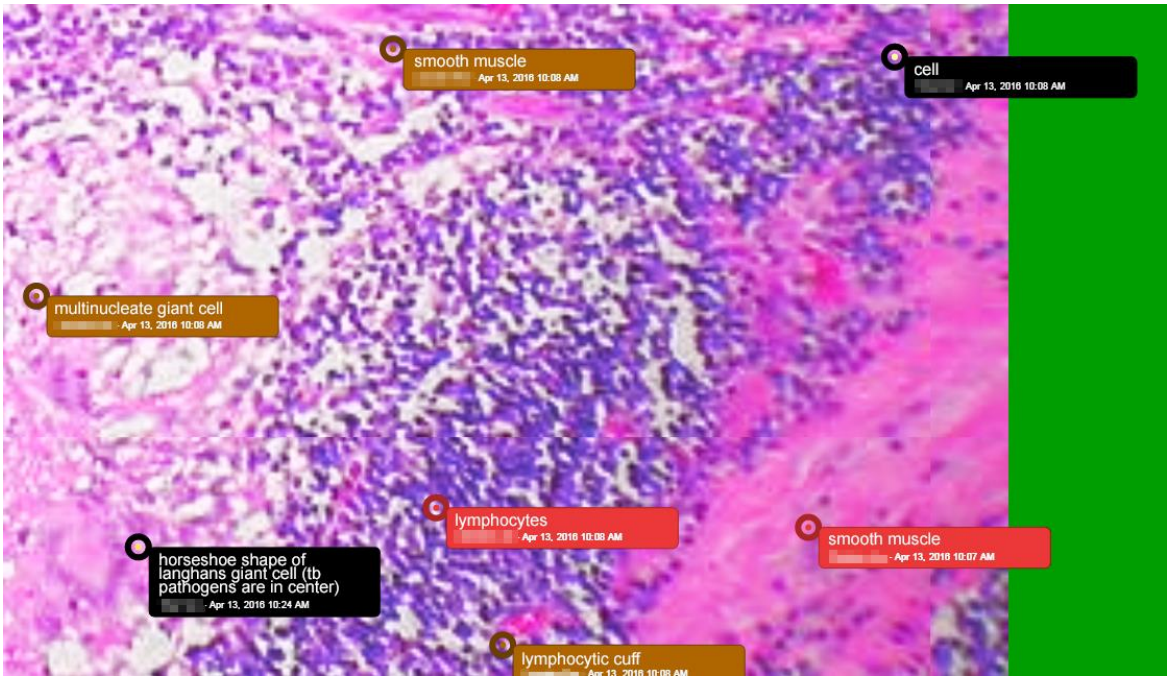

Figure 1: Typical example of student-annotated Pictation image. Annotations were usually made by only a few students in each group independently.

We gathered student perceptions of the Pictation learning activity through a questionnaire comprising eight Likert-scale and two open-ended questions. The questions interrogated:

- general aspects of the pathology course (e.g., To what extent did attending lectures improve your understanding of the principles of pathology? To what extent did attending tutorials improve your understanding of the principles of pathology?); and
- specific features of learning with Pictation, adapted from Gilbert and Driscoll's (2002) instructional conditions for social constructivist learning environments (e.g., To what extent did working in a group on Pictation improve your understanding of the principles of pathology? To what extent did working on questions in your own time improve your understanding of the principles of pathology?).

Our evaluation of the Pictation learning activity revealed mixed success: only 37% of respondents (n=26) found annotating images using Pictation, and only 21% of respondents (n=15) found working in a group on Pictation helped them understand the principles of pathology. Given the mixed results, we decided to further interrogate the challenges students faced in participating in the Pictation learning activity. In this paper, we identify challenges encountered and lessons learnt from an educational technology initiative that did not meet initial expectations.

In the questionnaire, students were asked to rate the usefulness of the Pictation annotation activity and explain their responses; students frequently wrote about their challenges in the open-text responses. To understand students' challenges, we analysed these open-text responses according to Thomas' (2006) general inductive approach, suitable for analysing qualitative course evaluation data. Authors one and two read all the open-text responses and, individually, created and assigned categories to every response. Then the two authors met to negotiate their categories (e.g., "Good for self-study" and "Good for revision" were combined into "Good for revision"), and finally arrived at the distribution of categories shown in Figure 2.

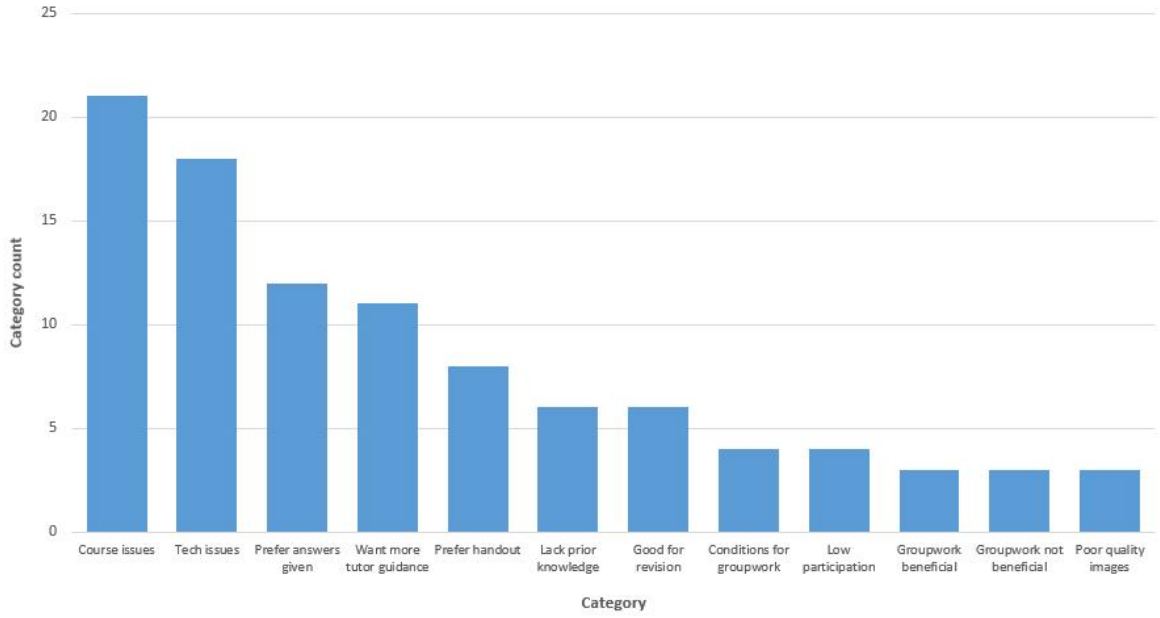

Figure 2: Distribution of categories from open-text responses.

While students frequently wrote about challenges in their open-text responses, they also wrote about things unrelated to challenges (e.g., Pictation was good for revision). Referring only to categories related to students' challenges, we designed questions for two focus group interviews. Since the aim of the focus groups was to deepen our understanding of student challenges in learning in social constructivist ways, we excluded from the interview questions issues not directly related to the Pictation learning activity: for example, logistical course issues or technical issues that had already been resolved.

We conducted two hour-long focus group interviews (FG1 and FG2) with students to follow up responses to the questionnaire. These group interviews were conducted with two of the tutorial groups noted to have the most overall use of Pictation. The interviews gave us a better understanding of students' challenges, and the relative importance of these challenges: for example, while only hinted at in the questionnaire, students' discomfort with exposing their inadequate understanding to peers emerged as an important challenge in the focus groups.

Findings and discussion

Analysis of the questionnaire and interviews highlighted three primary challenges of implementing social constructivist learning in the Pathology tutorials:

- inadequate prior knowledge;
- embarrassment in exposing one's inadequate understanding to peers; and
- need for certainty.

We will now describe and discuss these challenges sequentially.

Inadequate prior knowledge

We initially planned for students to collectively solve case questions before the tutorial. We assumed that students would be able to engage in the pre-tutorial activity because they were third-year students for whom the topic was not totally new: Kirschner, Sweller, and Clark (2006) found that novice learners in constructivist environments often lacked necessary prior knowledge to integrate new information, but that non-novice learners would benefit from such minimally guided activities.

The aim of the pre-tutorial activity was to give students a group space to explore and articulate their developing understandings of pathological features before being given correct answers in class. However, in the questionnaire, only 29% of students found the ability to annotate images prior to tutorials helpful in understanding the principles of pathology. In the open-text comments from the questionnaire, students identified their lack of prior knowledge as a limiting factor for engaging with the Pictation activity:

> I struggled to comprehend what I was supposed to see, although it makes more sense once we've gone through it [during the tutorial].
>
> We didn't understand the pictures very much, but I think that's more on our behalf.
>
> It was helpful going through the images during the tutorial, but not trying to do them at home because I had little idea of what I was looking at until I got to the tutorial.

We further explored their lack of prior knowledge in the focus group interviews. Several students supported the view that lack of prior knowledge hindered their participation in the pre-tutorial Pictation activity: "[some] things that we are labelling are so far out and no one knew what was going on" (Student 5, FG1); "labelling the pictures before we had gone over them in the tutorials was difficult" (Student 4, FG1). Seemingly, the Pictation case questions were beyond our students' ZPD.

However, some students said they could participate in the pre-tutorial Pictation activity, provided they first engaged in some form of self-directed learning:

> I annotated the ones that I could understand quite well (...) [and for the questions I was unsure of] I found myself doing more research when I answered Pictation questions (...) I researched the textbook and stuff. (Student 13, FG2)

Similarly, Student 12 (FG2) reported that she "Googled" in order to attempt the pre-tutorial activity, adding that the learning activity "forces you to do the background study". That some students engaged in self-directed "background study" was one serendipitous outcome of the project. However, most students did not engage in self-directed learning, and hence lacked the necessary prior knowledge to participate in the learning activity (even after attending relevant lectures).

This challenge poses a particular dilemma for teachers wanting to implement social constructivist learning because such approaches inherently imply that students have incomplete prior knowledge. Well-designed social constructivist activities should be within students' ZPD: beyond individual problem-solving, but achievable via collective problem-solving. However, current research offers little guidance to teachers regarding how much prior knowledge would be incomplete but adequate (Wass & Golding, 2014). To make our activity more achievable, we could have designed easier case questions or positioned the Pictation activity post-tutorial (suggested by some students). However, this would likely result in a learning activity achievable by individual problem-solving, and not requiring collaborative meaning-making (as intended).

To design learning activities that better align with students' ZPD, we recommend that teachers:

- design case questions of varying difficulty (e.g., an easy Q1 and a difficult Q2) and adjust difficulty as students progress to situate activity within students' ZPD;
- group students of differing abilities together and encourage them to help each other; and
- suggest ways for students to participate even when they are unsure (e.g., Student 12 mentioned that she would add question marks to annotations when she was unsure of her answers).

However, even if we address students' inadequate prior knowledge (e.g., designing activities that encourage student participation even with gaps in their understanding), we may still face a social challenge associated with exposing one's incomplete understanding to peers. This emerged as our second challenge from the survey responses and focus group interviews, and is discussed below.

Embarrassment in exposing one's inadequate understanding to peers

Students were generally uncomfortable exposing their inadequate understanding to peers, and hence were reluctant to engage with the group annotation activities. We had not anticipated this challenge when designing the Pictation activities; we assumed our students would be comfortable with collaborative learning as collaboration and teamwork are explicitly promoted as graduate attributes in Health Science courses (Rudland & Mires, 2005). Our assumption was reinforced because this group of students had studied together for the past three years.

However, from our questionnaire, only 21% of students found working in a group on Pictation helped them better understand the principles of pathology. Comments from the questionnaire and focus groups revealed many students felt uncomfortable annotating images incorrectly in front of peers:

> Was often worried about labelling diagrams in case I was wrong and everyone could see.
>
> I wouldn't mind if it was just myself and the tutor. I wouldn't mind putting what I thought was wrong, and no one else could see it.
>
> You basically publicly embarrass yourself.

Some students remarked that they were comfortable exposing incomplete understanding in front of some peers, but not others: "I'm comfortable with this group, not with other groups... because I know that [this group] won't judge me for giving the wrong answer" (Student 13, FG2). In general, encouraging students to articulate inadequate understanding publicly is a known challenge in higher education (Fritschner, 2000), particularly in more competitive courses: for example, the competitive first year Health Science course in New Zealand (from which our students graduated) leaves some students feeling "pitted against each other from the start" (Jameson & Smith, 2011, p. 60). Such students may hence be unwilling to expose any 'weaknesses' to peers.

As stressed above, social constructivist learning activities inherently require student participation with incomplete understanding, and assume students are willing to expose their incomplete understandings to peers. This assumption should be questioned and addressed when implementing social constructivist activities.

Some students suggested that anonymising annotations might make them more willing to expose inadequate understanding. However, this is not recommended because ownership of the emerging body of knowledge is a crucial characteristic of social constructivist learning (Scardamalia & Bereiter, 2006).

To design learning activities where students are more comfortable exposing inadequate understanding, we recommend that teachers:

- create safe learning environments. Palloff and Pratt (2007) provide useful strategies for creating a safe environment for online learning: for example, the establishment of ground rules that respect a diversity of views, so students feel safe in expressing themselves without fear of punishment; and
- position these learning environments as spaces where students can deliberately explore and articulate their incomplete understandings.

As before, even if we successfully make students comfortable in exposing inadequate understanding to peers, we may still face a challenge if students are solely concerned with getting 'correct' answers. This emerged as the third principal challenge and is discussed below.

Need for certainty

We initially planned for students to solve case questions on Pictation by themselves, foregrounding the multiple meanings students make and their collective negotiation to reach a shared understanding. However, from the questionnaire, students expressed that they preferred to be given the correct answer, the lack of which hindered their participation in the Pictation activity:

> There was uncertainty of being correct.
>
> Never know if what is on Pictation is right.
>
> Please give us some examples of fully-labelled, correct answers. Otherwise, it is the blind leading the blind.

Students expanded on this need for certainty in the focus group interviews:

> many people liked annotating the pictures during the tutorial [when the tutor is giving the answers], so they actually know it's right (Student 1, FG1)
>
> that will be the correct answer because it's what I got from [tutor] (Student 14, FG2).

In the same vein, many students expressed that Pictation was a good tool for revision, provided that correctly-labelled images were given: 61% responded in the questionnaire that reviewing Pictation images post-tutorial was beneficial to their understanding. Interestingly, one student did highlight a benefit of articulating incorrect responses: "at least you know what you don't know, instead of [not knowing] what you don't know" (Student 15, FG2). Few other students shared this view.

Again, this challenge is particularly problematic for teachers wanting to implement social constructivist learning because these approaches generally require students to be comfortable with the uncertainty of "consensus between individuals" (Adams, 2006, p. 246) and not need to be told the "final answer" (Student 12, FG2).

To design social constructivist learning activities where students are more comfortable with uncertainty, we recommend that teachers:

- design open-ended case questions that genuinely allow multiple meanings to be made; and
- reassure students that correct answers will be given after (a) student participation in pre-tutorial activities and (b) the class has discussed possible answers during tutorials.

Some students made this last recommendation in their free text comments: "It would be great if answer is provided after the tutorial"; "Have correct labelling available afterward". Nonetheless, one student warned that if students knew correct answers were forthcoming, few would likely attempt the pre-tutorial activity (Student 13, FG2).

Conclusion

We designed a social constructivist learning activity to help students learn to make meaning of clinical images collaboratively. We identified three challenges in implementing social constructivist learning related to: inadequate prior knowledge; embarrassment in exposing one's inadequate understanding to peers; and need for certainty. These challenges are related to inherent characteristics of social constructivist learning: we speculate that we are grappling with specific interminable tensions between theory and practice.

We propose seven recommendations to address the above challenges:

- design social constructivist activities of varying difficulty and adjust the difficulty as students progress to situate activities within students' ZPD;
- group students of differing abilities together and encourage them to help each other;
- suggest ways for student participation even when they are unsure;
- create safe learning environments;
- position activities as spaces for deliberately exploring and articulating incomplete understandings;
- design open-ended activities that genuinely allow multiple valid meanings to be made; and
- reassure students that correct answers will be given after (a) participation in the activity and (b) possible answers are discussed collectively.

Our future work will involve implementing these recommendations into the 2016 Principles of Pathology curriculum, as well as integrating Pictation into other courses, such as Medicine and Radiology.

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